

(1983).

FIG. 1a

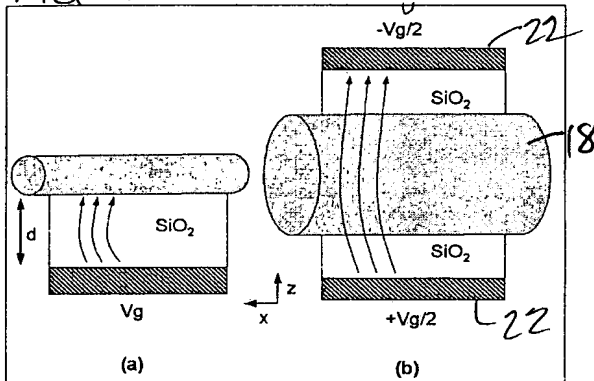


FIG. 2

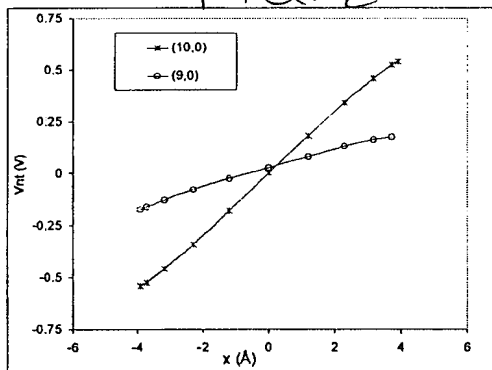


FIG. 3a

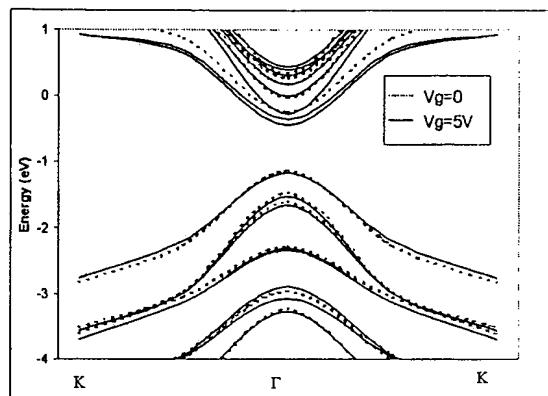


FIG. 3b

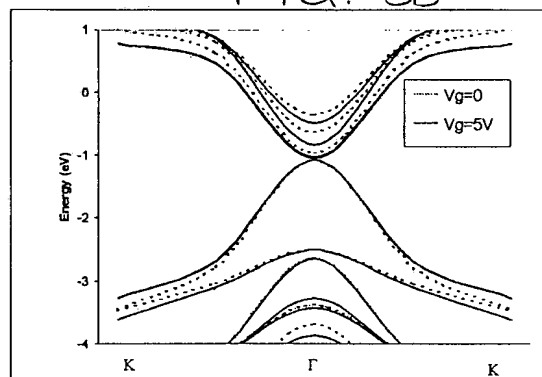
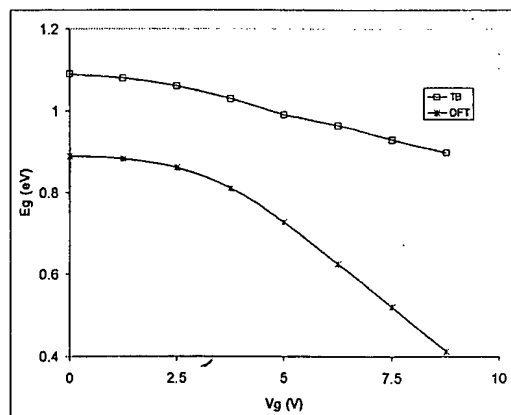
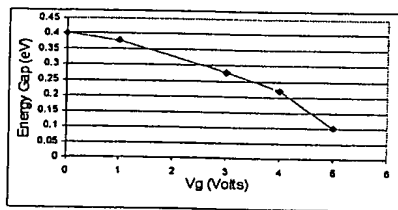


FIG. 4



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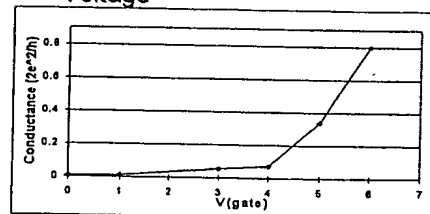
Energy Gap change with gate Voltage



• Energy gap reduces from 0.4eV to 0.1eV

FIG. 5

Conductance change with gate Voltage



•  $V_g=0V$   $C = 0.011 \ 2e^2/h$

•  $V_g=6V$   $C = 0.81 \ 2e^2/h$

FIG. 6

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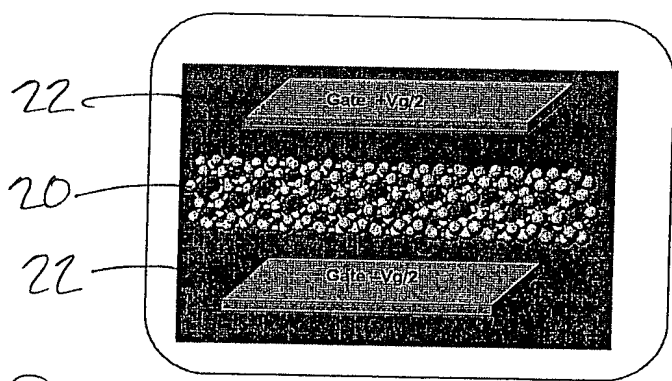


FIG. 7(a)

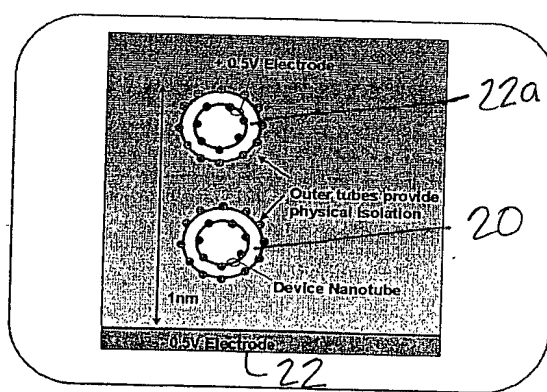
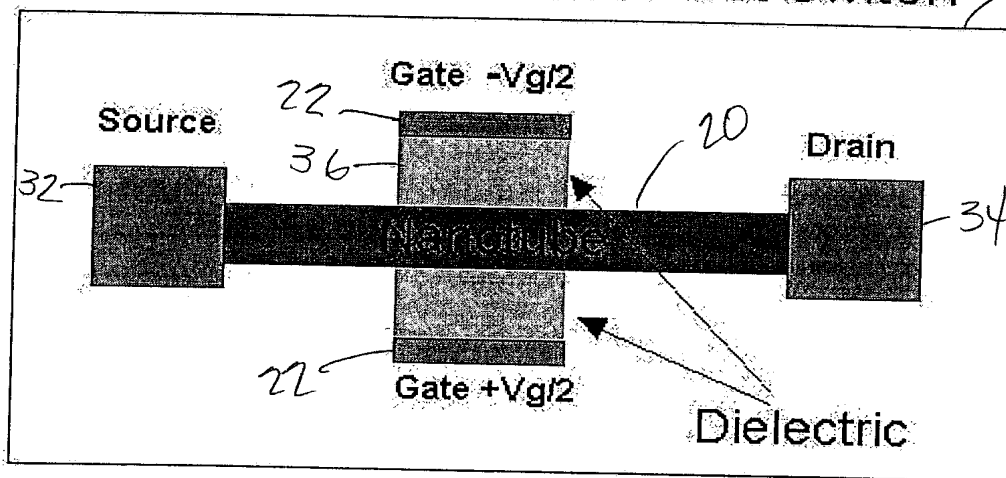


FIG. 7(b)

FIG. 8

# 1. Nanotube Field Effect switch



- The split-gate generates a potential gradient about the tube X-section.
- The energy-gap narrows as a result of the potential gradient.
- This causes a change (increase) in the source-drain conductance.
- The gate can be across part or all of the nanotube.

## Variations on nanotube field effect switch

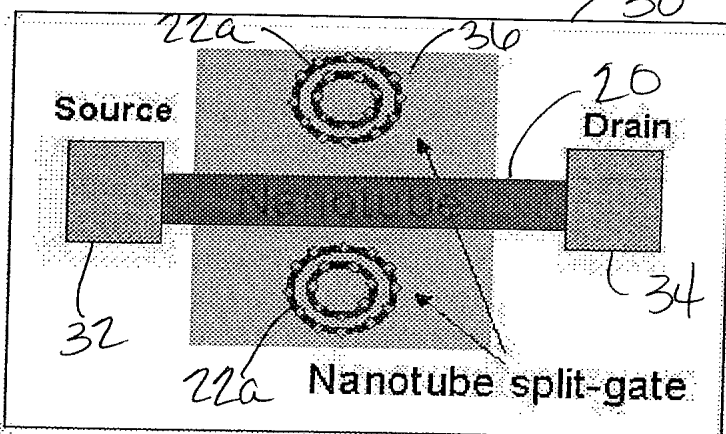


Fig. 9(a)

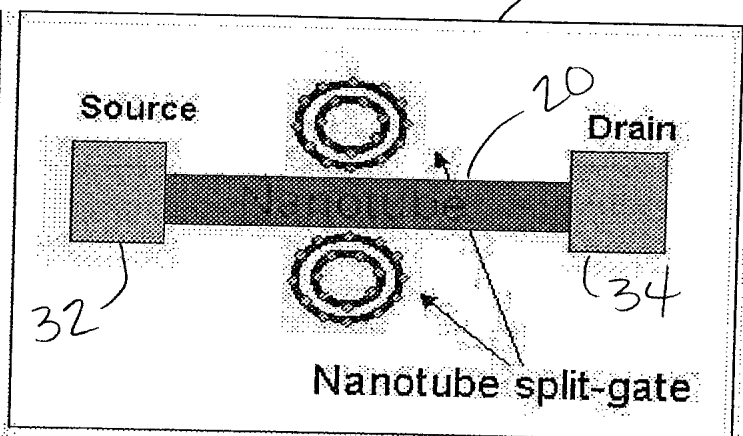


Fig. 9(b)

- A) Single or multi-wall tubes are used as gate electrodes. There is a dielectric ( $\text{SiO}_2$  etc.) between the tubes.
- B) Same as (a) except there is no gate dielectric. The tubes form a crossing junction. There is capacitor action because there is only weak inter-tube conductance.

### 3. Modulated optical absorption

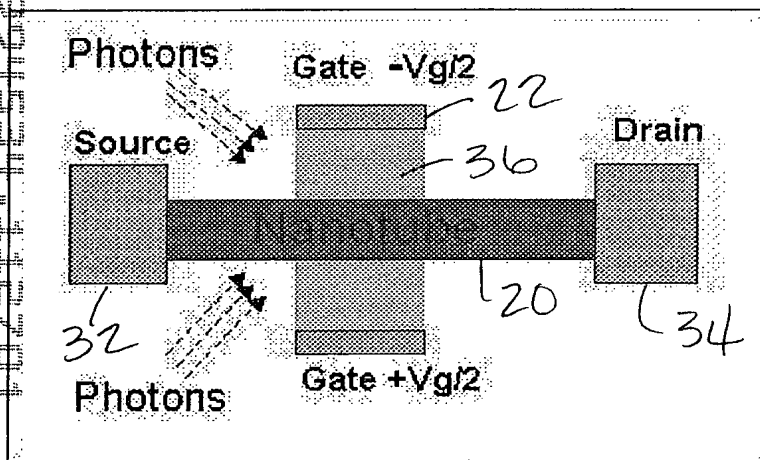


FIG. 10(a)

- The potential gradient narrows the energy gap and therefore shifts the optical absorption edge (illustrated in (b) for three different gate voltages)
- The energy gap and band-structure can be tuned to absorb specific photon energies. Electron-hole pairs are created when the photons are absorbed and results in a source-drain current. This is a typical photo-detector operation, except that it is tunable using energy gap modulation

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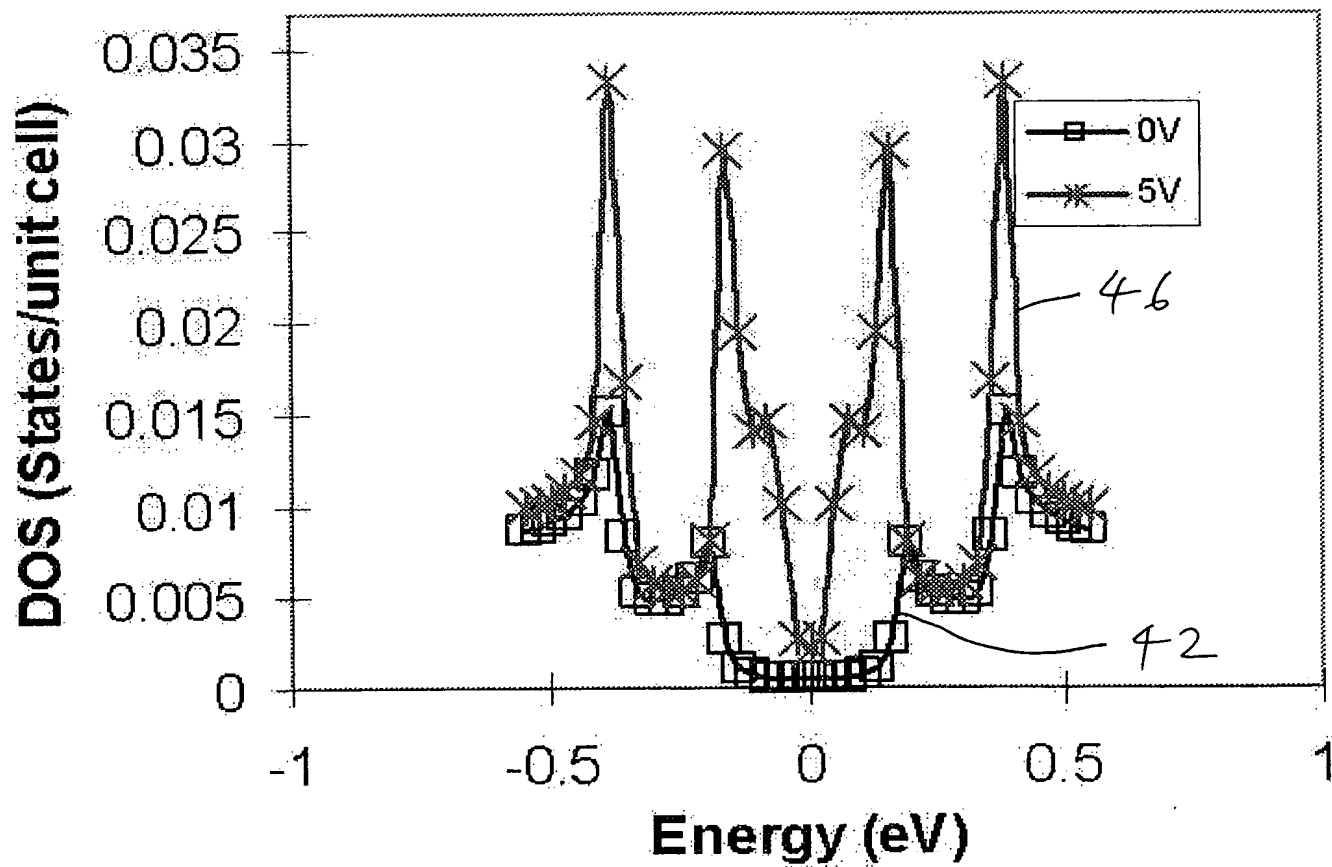
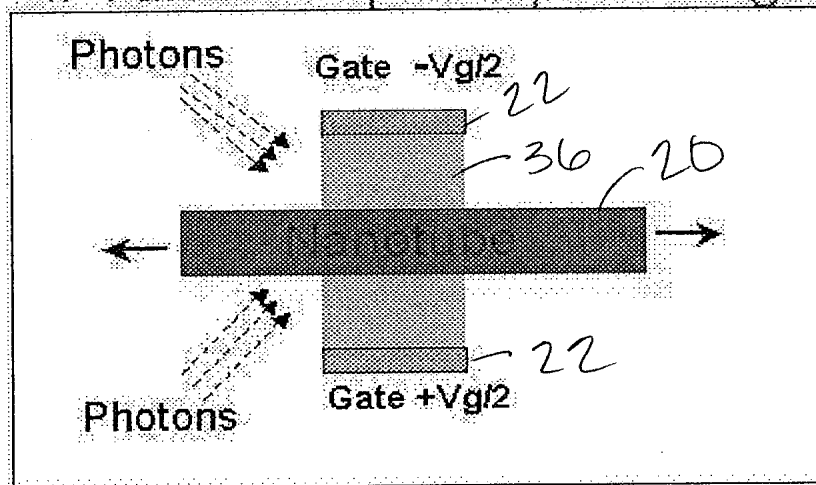


Fig. 106

FIG 11

#### 4. Tunable optical polaron generator



- Electron hole pairs are generated when the photons are absorbed.
- The electron hole pairs form polarons which cause the tube to deform mechanically (elongate or bend).
- Our claim is that we can control this process by modulating the amount of photon absorption.



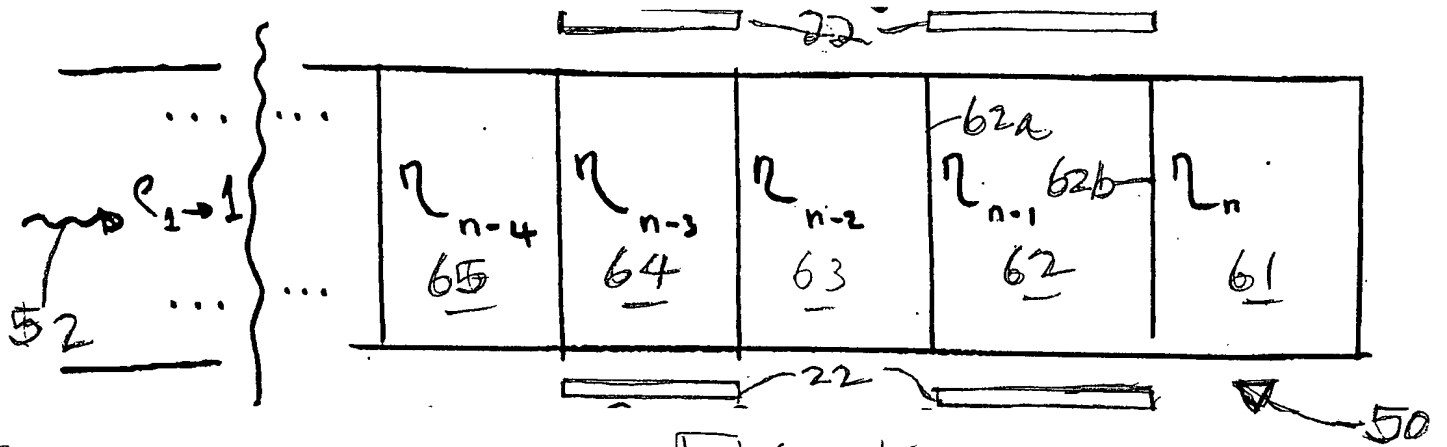


FIG. 12

FIG. 13

Side-emitting semiconductor laser  
Distributed Bragg reflectors on either end

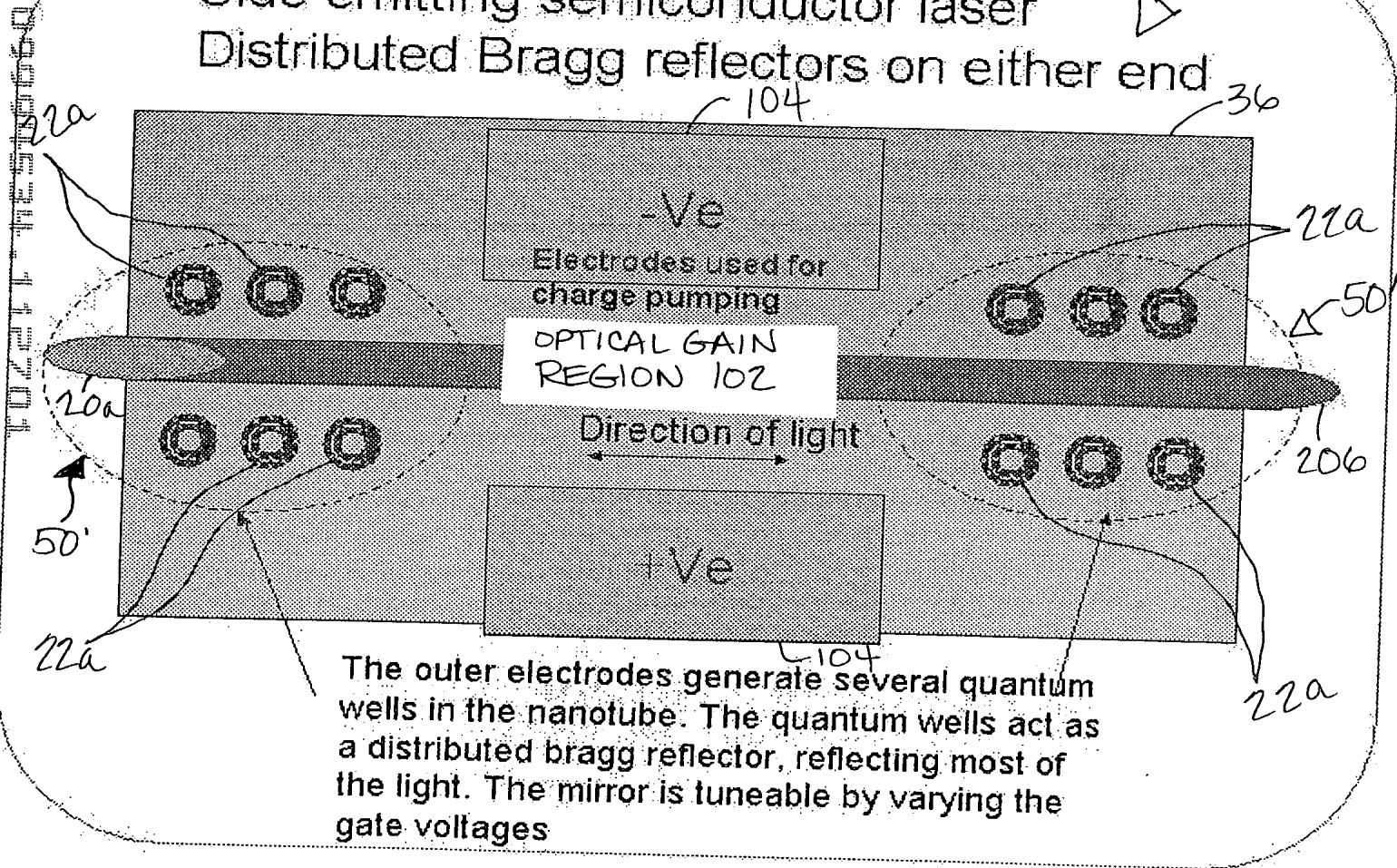


FIG. 14a

120

Verticle-emitting semiconductor laser (VCSEL)  
Distributed Bragg reflectors on top and bottom

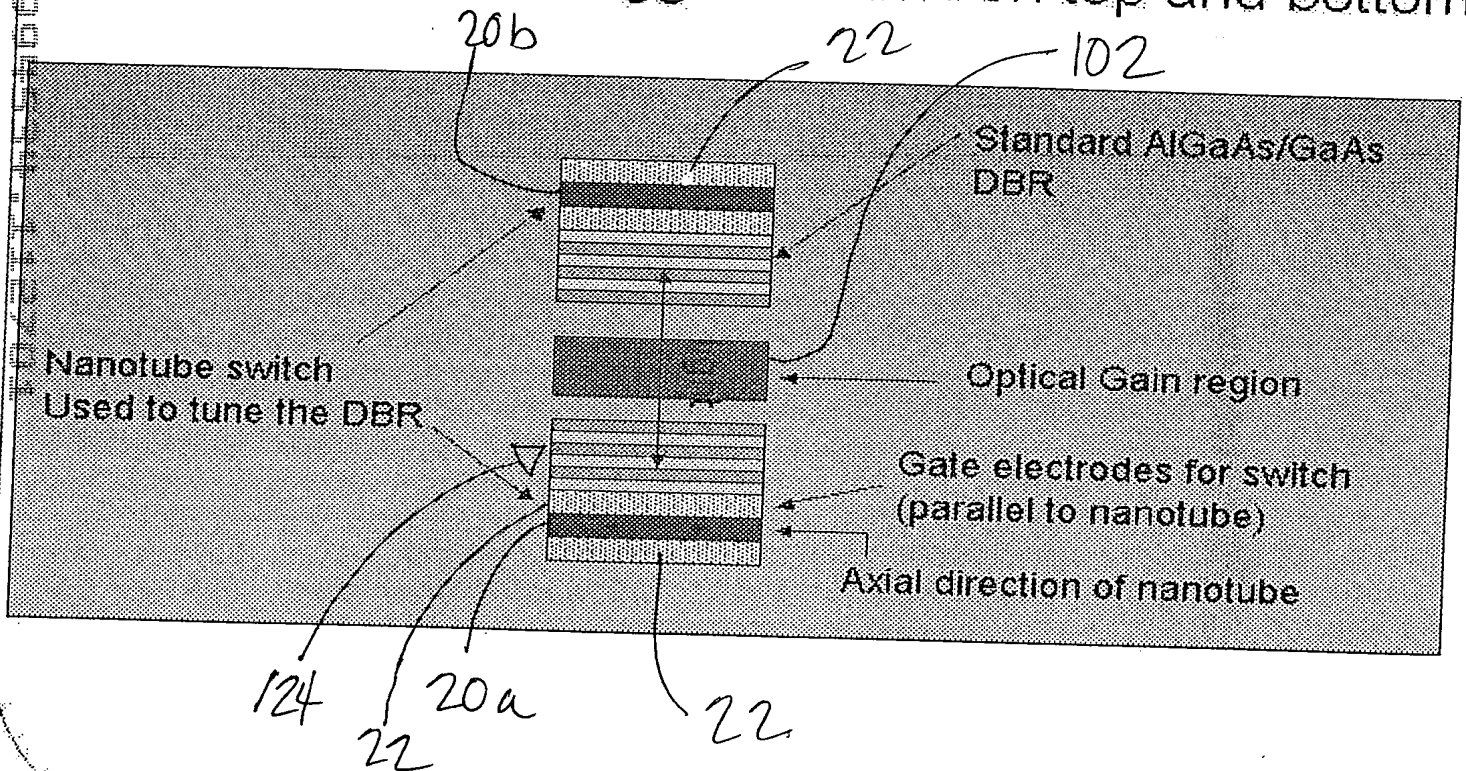
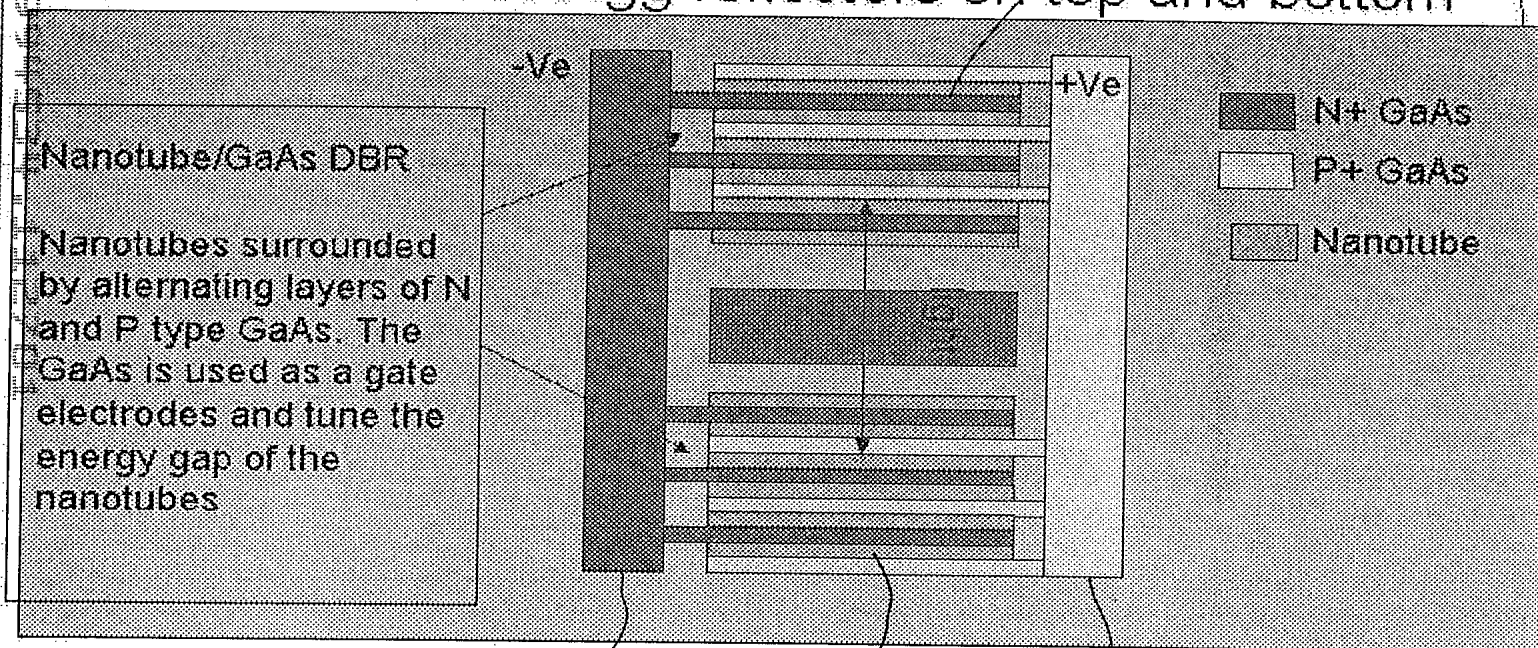


Fig. 14b

130

Verticle-emitting semiconductor laser (VCSEL)  
Distributed Bragg reflectors on top and bottom



This is a neat way to bias many layers of nanotubes with an optically suitable gating material

134

20

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# Quantum Computing example

FIG. 15a

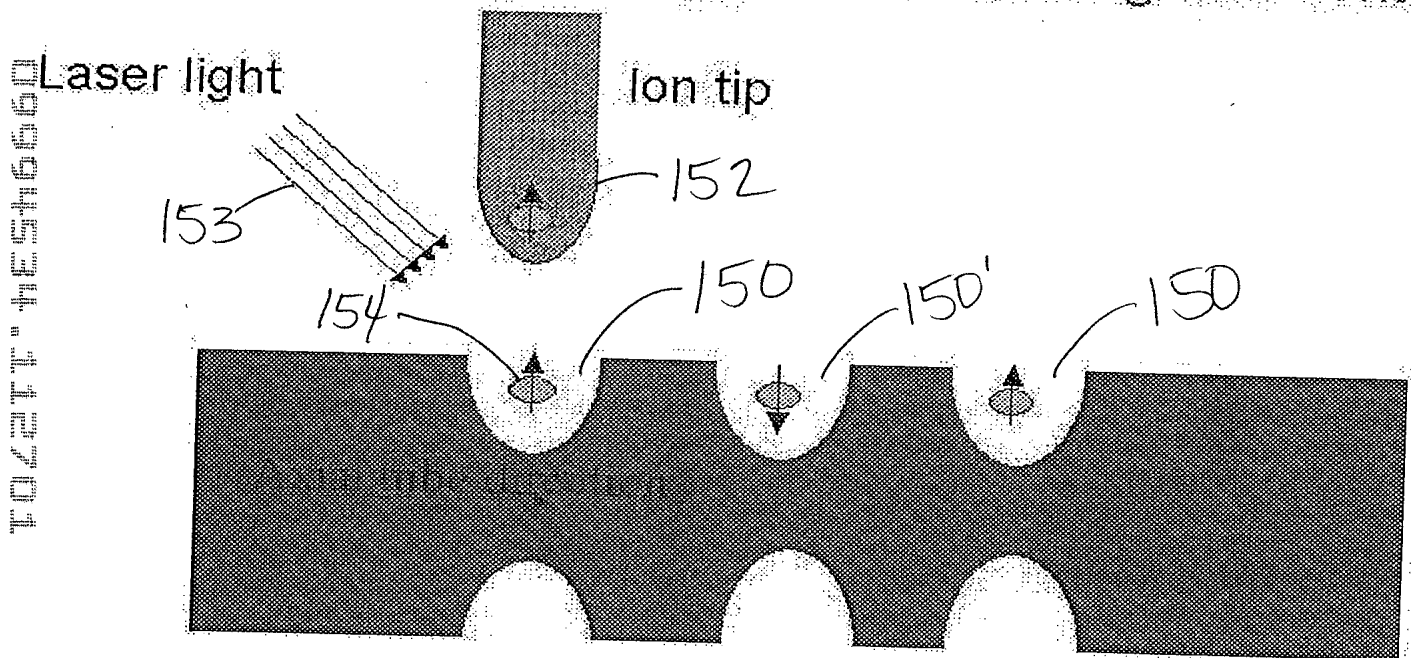


- Multiple quantum wells are created along the tube.
- In this example the spins in the outer wells are used to manipulate the spins in the center well.
- The wells used to store confine electrons in well defined spin states i.e. ↑ Or ↓

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FIG. 15b

Quantum Computing example: Reading and Writing



- Using a laser pulse in conjunction with an ion tip, the electron spin state from the tip is placed onto the Q-well
- When the laser is off the state in the Q-well is read by the ion tip.